Designation: D5607 – 16

Standard Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force[1]

This standard is issued under the fixed designation D5607; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This test method establishes requirements and laboratory procedures for performing direct shear strength tests on rock specimens under a constant normal load. It includes procedures for both intact rock strength and sliding friction tests, which can be performed on specimens that are homogeneous, or have planes of weakness, including natural or artificial discontinuities. Examples of an artificial discontinuity include a rock-concrete interface or a lift line from a concrete pour. Discontinuities may be open, partially or completely healed or filled (that is, clay fillings and gouge). Only one discontinuity per specimen can be tested. The test is usually conducted in the undrained state with an applied constant normal load. However, a clean, open discontinuity may be free draining, and, therefore, a test on a clean, open discontinuity could be considered a drained test. During the test, shear strength is determined at various applied stresses normal to the sheared plane and at various shear displacements. Relationships derived from the test data include shear strength versus normal stress and shear stress versus shear displacement (shear stiffness).

NOTE 1—The term "normal force" is used in the title instead of normal stress because of the indefinable area of contact and the minimal relative displacement between upper and lower halves of the specimen during testing. The actual contact areas during testing change, but the actual total contact surface is unmeasurable. Therefore nominal area is used for loading purposes and calculations.

NOTE 2—Since this test method makes no provision for the measurement of pore pressures, the strength values determined are expressed in terms of total stress, uncorrected for pore pressure.

1.2 This standard applies to hard rock, medium rock, soft rock, and concrete.

1.3 This test method is only applicable to quasi-static testing of rock or concrete specimens under monotonic shearing with a constant normal load boundary condition. The constant normal load boundary condition is appropriate for problems where the normal stress is constant along the discontinuity. The constant normal load boundary condition may not be appropriate for problems where shearing is dilatancy controlled and the normal stress is not constant along the discontinuity.

1.4 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4.1 The procedures used to specify how data are collected/recorded and calculated in this standard are regarded as the industry standard. In addition, they are representative of the significant digits that generally should be retained. The procedures used do not consider material variation, purpose for obtaining data, special purpose studies, or any considerations for the user's objectives; and it is common practice to increase or reduce significant digits of reported data to commensurate with these considerations. It is beyond the scope of these test methods to consider significant digits used in analysis methods for engineering design

1.5 *Units*—The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units, which are provided for information only and are not considered standard. Reporting of test results in units other than SI shall not be regarded as nonconformance with this test method.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.12 on Rock Mechanics.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

***A Summary of Changes section appears at the end of this standard**

Used in Engineering Design and Construction
D5079 Practices for Preserving and Transporting Rock Core Samples (Withdrawn 2017)[3]
D6026 Practice for Using Significant Digits in Geotechnical Data
E4 Practices for Force Verification of Testing Machines
E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

2.2 *ISRM Standard:*[4]
Suggested Methods for Laboratory Determination of the Shear Strength of Rock Joints: Revised Version

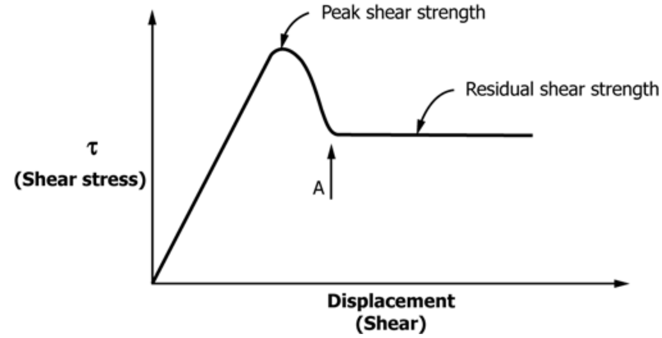

FIG. 1 Generalized Shear Stress and Shear Displacement Curve

3. Terminology

3.1 *Definitions*—For definitions of common technical terms used in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *apparent stress, n*—nominal stress, that is, external load per unit area; calculated by dividing the externally applied load by the nominal area.

3.2.2 *asperity:*

3.2.2.1 *quality, n*—the roughness of a surface.

3.2.2.2 *asperity feature, n*—a surface irregularity ranging from sharp or angular to rounded or wavy.

3.2.2.3 *asperities, n*—the collection of a surface's irregularities that account for the surface's roughness.

3.2.3 *discontinuity, n*—an abrupt change, interruption, or break in the integrity or physical properties of rock, such as a bedding plane, fracture, cleavage, crack, joint, or fault where the opposing rock surfaces may be *planar* to *nonplanar* and *matching* to *misfit*.

3.2.4 *gapped discontinuity, n*—consists of opposing rock surfaces separated by an open or filled space.

3.2.5 *tight discontinuity, n*—consists of opposing rock surfaces in intimate and generally continuous contact; it may be valid to treat such a discontinuity as a single surface.

3.2.6 *intact shear strength, n*—the peak shear resistance (in units of stress) of an intact rock specimen or of a specimen containing a completely healed discontinuity.

3.2.7 *nominal area, n*—area obtained by measuring or calculating the cross-sectional area of the shear plane and calculated after its relevant cross-sectional dimensions are determined.

3.2.8 *residual shear strength, n*—the shear stress, (see Fig. 1), corresponding to a specific normal stress, for which the shear stress remains essentially constant with increasing shear displacement.

3.2.8.1 *Discussion*—In most cases, the shear stress after reaching Point A is the residual shear strength.

3.2.9 *shear stiffness, n*—represents the resistance of the specimen to shear displacements under an applied shear force prior to reaching the peak shear strength, which is calculated by dividing the applied apparent shear stress by the resulting shear displacement (slope of the curve prior to peak shear strength, Fig. 1).

3.2.10 *sliding friction shear strength, n*—the peak shear resistance (in units of stress) of a rock specimen along an open discontinuity.

4. Summary of Test Method

4.1 While maintaining a constant force normal to the nominal shear plane of the specimen, an increasing external shear force is applied along the designated shear plane to cause shear displacement. The applied normal and shear forces and the corresponding normal and shear displacements are measured and recorded. These data are the basis for calculating the required parameters.

5. Significance and Use

5.1 Determination of shear strength of a rock specimen is an important aspect in the design of structures such as rock slopes, dam foundations, tunnels, shafts, waste repositories, caverns for storage, and other purposes. Pervasive discontinuities (joints, bedding planes, shear zones, fault zones, schistosity) in a rock mass, and genesis, crystallography, texture, fabric, and other factors can cause the rock mass to behave as an anisotropic and heterogeneous discontinuum. Therefore, the precise prediction of rock mass behavior is difficult.

5.2 For nonplanar joints or discontinuities, shear strength is derived from a combination base material friction and overriding of asperities (dilatancy), shearing or breaking of the asperities, and rotations at or wedging of the asperities. Sliding on and shearing of the asperities can occur simultaneously. When the normal force is not sufficient to restrain dilation, the shear mechanism consists of the overriding of the asperities. When the normal load is large enough to completely restrain dilation, the shear mechanism consists of the shearing off of the asperities.

5.3 Using this test method to determine the shear strength of an intact specimen may generate overturning moments which could result in an inclined shear break.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] "ISRM Suggested Methods for Laboratory Determination of the Shear Strength of Rock Joints: Revised Version", R. Ulusay (ed.), The ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 2007-2014, DOI: 10.1007/978-3-319-07713-0, Springer-Verlag Wien 2013.